DRAWINGS

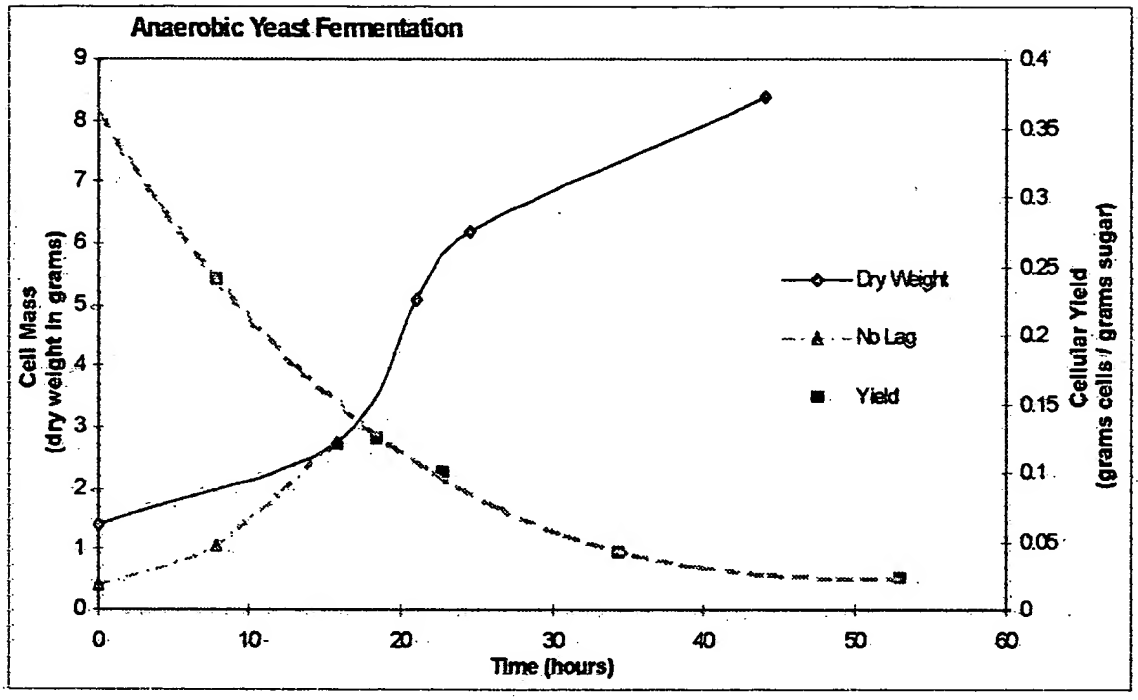
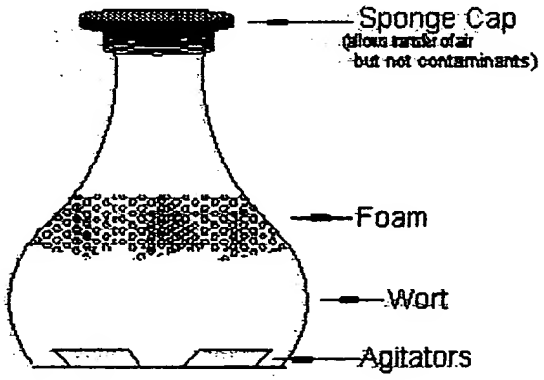


Figure 1



2 liter Fernbach Flask

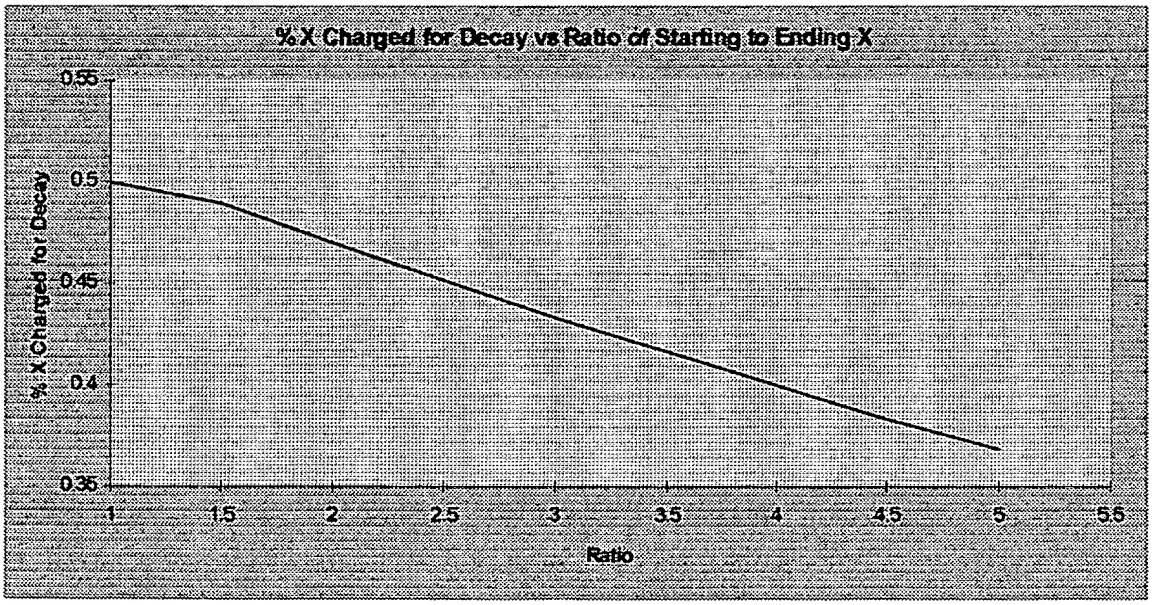
Oxygen transfer is limited by the small surface area on the top, and the foam that forms.

Figure 2

Time During Fermentation	Yield (g cells/ g sugar)	Ammonia Needed (grams)	Water Produced (grams)	CO_2 Produced (liters)	Yeast Produced ($C_4H_7O_2N$) (grams dry wt.)	Ethanol Produced (C_2H_6O) (grams)*
1st 3rd	.15	18.70	5.1	22.51	15.04	41.19
2nd 3rd	.052	.65	1.79	25.54	5.20	47.68
3rd 3rd	.023	.29	.79	26.44	2.30	49.61
Overall	.05	.626	1.72	25.60	5.00	48.52

*** For ethanol volume, divide weight (in grams) by its' density (0.789 grams/ml)**

Table 1

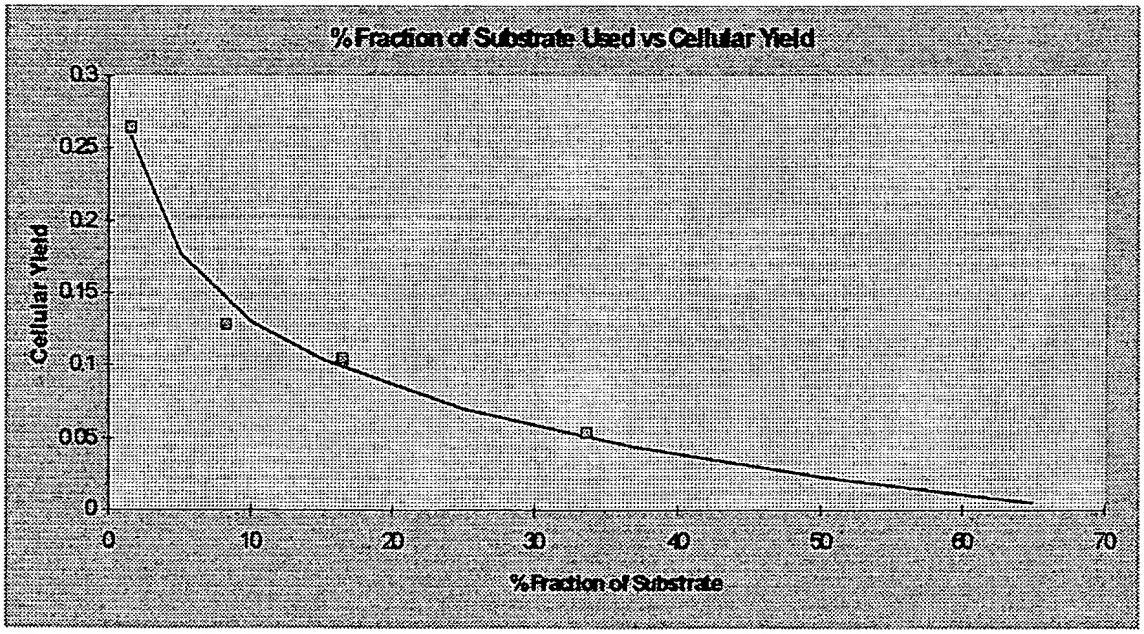


EQXchrgd $Xchrgd = 0.5040764476609 \times EXP(-0.0816252748703 \times Ratio)$

Figure 3 / Equation 10

Sample Name	Time (hours)	X weight (grams)	S.G. Reading (g S/l. see EQSG)	Measured CO2 Flow (ml / min)
t_0	0	1.415	183.59	0
t_1	15.75	2.73	178.11	3.944
t_2	21.03	5.1	158.94	12.344
t_3	24.5	6.18	147.99	15.074
t_4	44.08	8.38	95.965	7.234

Table 2



Comparison of the four data points with the yield curve (EQ%used)
$Y = -6.67814305038 \times 10^{-2} \times [\ln(\%used)] + 0.284841059276$
log fit; r^2 : -.9924

Figure 4

b=.004/hr

Test Fermentation Data

A Interval	B Observed New X	C Total hours of interval	D Mass lost from starting X decay	E Sub-total new mass (B + D)	F Ratio new X/Start X (Starting X + E) / Starting X	G Charge what new mass b? (EQXchrgd)
$t_0 - t_1$	1.315	15.75	0.089145	1.404145	1.9923	0.471
$t_1 - t_2$	2.37	5.28	0.0576576	2.4276576	1.88925	0.475
$t_2 - t_3$	1.08	3.2	0.06528	1.14528	1.22457	0.5
$t_3 - t_4$	2.2	19.58	0.4840176	2.6840176	1.434307	0.493

A Interval	H Decay of new mass (E x G x C x .004)	I Total new mass yield (E + H)	Amount of sugar used (g/l)	J Average % S consumed	K Yield g X / g S	L Yield (fm curve) g X / g S	M % of actual Yield
$t_0 - t_1$	0.0416652	1.4458102	5.48	1.4925	0.263833977	0.258098264	97.83%
$t_1 - t_2$	0.024354261	2.45201186	19.17	8.206	0.127908809	0.144275124	112.80%
$t_2 - t_3$	0.007329792	1.152609792	10.95	16.409	0.105261168	0.097997972	93.10%
$t_3 - t_4$	0.103634643	2.7876522	52.025	33.56	0.053582936	0.05021553	93.72%

Table 3

Evaluation of Test Fermentation

Interval	% fraction of S	Yield fm EQ%used	Ratio fm EQYld (l CO_2/g X)	Total new X (grams)
$t_0 - t_1$	1.4925	0.2580973	0.79324921	1.445803
$t_1 - t_2$	8.206	0.14427497	1.52663404	2.452006
$t_2 - t_3$	16.409	0.097998	2.3594534	1.1526299
$t_3 - t_4$	33.56	0.0502161	5.00801093	2.787623

Interval	liters CO_2 predicted fm model (g X x Ratio)	liters CO_2 predicted by actual Yield	Average measured CO_2 (ml / min)	liters CO_2 predicted fm avg of measured CO_2 flow rate at this interval
$t_0 - t_1$	1.1469	1.1192	1.972	1.8635
$t_1 - t_2$	3.7433	4.2872	8.144	2.58
$t_2 - t_3$	2.71968	2.5095	13.709	2.6321
$t_3 - t_4$	13.9604	12.9849	11.154	13.1037

Table 4